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What Does It Take to Teach Nonmajors Effectively?

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What Does It Take to Teach Nonmajors Effectively?

By Feryal Alayont, Gizem Karaali, and Lerna Pehlivan

Most MAA members teach mathematics at the college level, and many often teach courses intended for nonmajors. Indeed this is one of the main responsibilities of a mathematics department: offering service courses for client departments and general education courses for nonmajors. The three of us have been thinking about the question of how to teach nonmajors successfully for a while now. Finally we decided on a time-tested method of figuring things out: if you don't know what to do, ask the experts. We organized a panel titled "Effective Strategies for Teaching Classes for Nonmajors" for MAA MathFest 2012 and invited four panelists who we knew would have interesting and concrete things to say.

Thinking Skills

Our first panelist was Michael Starbird, professor of mathematics and University Distinguished Teaching Professor at the University of Texas at Austin. Starbird argued that teaching effective thinking skills, rather than math content, should be our main goal, especially in a course for nonmajors. His main concern, he said, was what habits of thinking students will use in their everyday lives fifteen years later.

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Starbird

Starbird then recounted the story of a student, Mary, discovering the countability of rationals with his guidance. Mary, we learned, went through multiple iterations of making mistakes and learning from them until she constructed her own proof. Thus, Starbird concluded, any student can experiment with, strive for, and achieve sophisticated mathematical thinking in a welcoming and encouraging classroom. (For more on Starbird's ideas, watch the video recording of his presentation "What Students Keep for Life: Elements of Effective Thinking" at a recent MAA-PREP workshop [Using Inquiry Based Learning in Second-Year Calculus and Courses for Prospective Teachers, *UCSB,* June 2012]: youtube.com/watch?feature=player_embedded&v=VVSaNNrkeEM. Mary's story starts at 59:53.)

Do's and Don'ts

Panelist Judith Grabiner, Flora Sanborn Pitzer Professor of Mathematics at Pitzer College, first told us what not to do in a course for liberal arts majors: Don't reteach algebra for the umpteenth time, and don't focus only on the hot topic of the day. She then outlined four guiding principles:

- Choose important mathematics.
- Base the course on something serious, of interest to many students, and where you have expertise.
- Take the time for most of the students to get most of the math because appreciating the beauty and excitement of mathematics requires understanding it.
- Draw on individual students' interests to create their own mathematical projects.

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Grabiner also listed sample projects (all chosen by students based on their interests) from two courses. Projects for the class Mathematics, Philosophy, and the Real World included the physics used in rock climbing, measuring blood alcohol content, music theory, geometry of dance, Laban's *Choreutics* and Plato's *Timaeus,* and quantitative measures in determining human attractiveness. Some projects for Math in Many Cultures were calendars (Jewish, Islamic, Christian), lattice multiplication in the Islamic world, fractions in the Aztec empire, the golden ratio in nature and art, and the geometry of tepees among the Plains Indians. (For more on Grabiner's thoughts, see her essay "How to Teach Your Own Liberal Arts Mathematics Course," *Journal of Humanistic Mathematics.*)

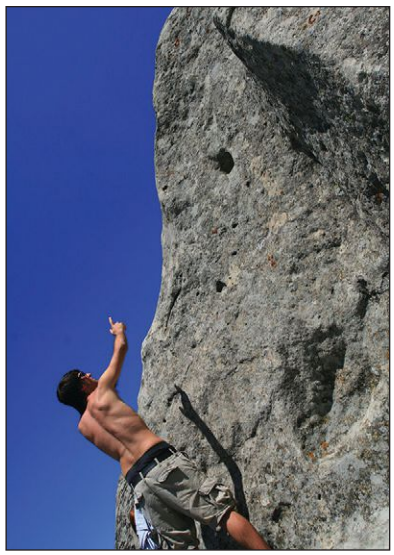
Assessment

Andrew Miller, associate professor of mathematics at Belmont University, and chair-elect of the SIGMAA of Quantitative Literacy, focused on assessment of courses for nonmajors. He based his remarks on a course for liberal arts majors called Mathematical Inquiry that aims to improve problem-solving and communication skills, introduce the concept of proof, and expose students to such topics as symbolic logic, hierarchy of infinities, fractals, exotic geometry, and discrete dynamical systems.

Assessment of the course indicated significant increases in content knowledge, understanding of the role of proof in mathematics, and beliefs that mathematics helps us understand the world around us and that creativity is

important in mathematics. However, significant decreases in positive attitudes toward mathematics (e.g., willingness to take another course, confidence in one's mathematical ability, perception of usefulness and relevance of mathematics to one's life) were also observed.

Miller then modified the course to include more examples of applications relevant to students' everyday lives (for example, RSA cryptography, measuring and modeling income inequality, consumer credit, and game theory) to compensate for these negative outcomes. (For details of the assessment study, see the article "Assessing a Mathematical Inquiry Course: Do Students Gain an Appreciation for Mathematics?" *PRIMUS*.)



Projects in classes for nonmajors can include the physics of rock climbing and the geometry of tepees.

Make It Personal

Rachelle DeCoste spoke last. She is assistant professor of mathematics at Wheaton College, and founder and director of the Career Mentoring Workshop for women finishing Ph.D.s in the mathematical sciences. DeCoste also began with general guidelines:

- Make material and assignments relevant to student interests.
- Make class as interactive as possible.
- Facilitate interaction among the students in class.

Then she listed some strategies for specific courses. In each meeting of DeCoste's Introductory Statistics, for instance, students submit a question about the point that confused them most in the daily reading ("the muddiest point"). They also read news articles chosen to emphasize such concepts as sample size and confidence interval, and to showcase common misleading uses of statistics.

In The Shape of Space, a course DeCoste developed, she uses hands-on activities to get students interested in topics, including symmetries, tilings, spherical geometry, and gluing. We heard about two projects from this course. In one, students create a "scrapbook of mathematics," exploring connections of real-life objects to mathematics. A second project, motivated by the movie *Flatland,* involves describing a topological space and its inhabitants creatively, using story, illustrations, or other art forms.

The MAA MathFest panel was well attended. The many questions and comments from the audience clearly indicate a need for and much interest in more effective and engaging math courses for nonmajors.

Panelists provided much food for thought; nonetheless, several questions on effectiveness of these courses (such as those that relate to class size, student diversity, and course mechanics) remain challenges for us all. We invite readers to continue and advance the discussion on teaching nonmajors.

Reading Suggestions

Edward Burger and Michael P. Starbird, *The Five Elements of Effective Thinking,* Princeton University Press (2012).

Judith V. Grabiner; "How to Teach Your Own Liberal Arts Mathematics Course," *Journal of Humanistic Mathematics* 1, no. 1 (January 2011): 101–118.

Barbara B. Ward, Stephen R. Campbell, Mary R. Goodloe, Andrew J. Miller, Kacie M. Kleja, Eninka M. Kombe, and Renee E. Torres; "Assessing a Mathematical Inquiry Course: Do Students Gain an Appreciation for Mathematics?" *PRIMUS* 20, no. 3 (2010): 183–203.

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